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Taxonomic notes on *Erythroxylum* (*Erythroxylaceae*) in Malesia

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Summary. Six species of *Erythroxylum* are recognized in Malesia, including *E. sarawakanum*, newly described here, and *E. iwahigense* and *E. latifolium* which are reinstated as species distinct from *E. cuneatum*. *E. iwahigense* forma *calcicola* is newly described from the Mulu limestone in Sarawak. Variation in leaf form within *E. cuneatum* is discussed. A key to the species of *Erythroxylum* in the Malesian region is also provided.

The genus *Erythroxylum* P. Browne was established in 1756 and typified by *E. areolatum* L. from South America (Plowman 1976). It is a pantropical genus of approximately 250 species (Schulz 1907). For the Malesian region, Payens (1958) recognized only two indigenous species (*E. cuneatum* (Miq.) Kurz and *E. ecarinatum* Burck), and Ng (1976) described a new species, *E. kochummenii*, endemic to Peninsular Malaysia. The genus has also been briefly treated for Sabah by Meijer (1968) and Cockburn (1976), for Peninsular Malaysia by Cockburn (1972), and for Sarawak by Ashton (1988).

A persisting taxonomic problem concerning species of *Erythroxylum* in Malesia has been the great variation in vegetative characters within *E. cuneatum sensu lato* as delimited by Payens (1958), whose bread concepts were followed by Meijer (1968) and Cockburn (1972, 1976). Ashton (1988), however, pointed out that in Sarawak two very different forms occurred, one confined to *kerangas* forest and the other found in peatswamp as well as lowland mixed dipterocarp forest.

In revising the family for the Tree Flora of Sabah and Sarawak, collections from Peninsular Malaysia, Borneo and the surrounding territories were studied. Our conclusions were that *E. iwahigense* Elmer and *E. latifolium* Burck should be recognized as species distinct from *E. cuneatum*, and that two distinct forms of *E. cuneatum* (forma *cuneatum* and forma *sumatranum*) can be recognized in Borneo. In addition, a new species, *E. sarawakanum*, from the Bako National Park, and a new form of *E. iwahigense* from the Mulu limestone in Sarawak, are described.

KEY TO *ERYTHROXYLUM* SPECIES AND FORMS IN MALESIA

1a. Flowers solitary.

2a. Leaves papery, apex acuminate with rounded tip; petioles (6–)7–10(–11) mm long. Pedicels 5–10 mm long. Fruit broadly obovoid, 20–22 × 15–20 mm, length:width ratio 1–1.4, more or less rounded in cross section, all locules in a single row ..... *E. kochummenii*

2b.Leaves leathery, apex acute with rounded or emarginate tip; petioles (2–)3–5(–6) mm long. Pedicels 15–25 mm long. Fruit ellipsoid, 8–12 × 3–5 mm, length:width ratio 1.8–2.9, rounded-triangular in cross section, locules arranged in a triangle.

3a. Leaves thick-leathery; spacing between lateral veins (measured along the midrib) 1–2(–2.5) mm ..... *E. iwahigense* forma *calcicola*

3b. Leaves thin-leathery; spacing between lateral veins (measured along the midrib) (3–)4–8(–10) mm ..... *E. iwahigense* forma *iwahigense*

1b. Flowers in clusters of 2–20, only sometimes solitary and then never exclusively so.

4a.Stamen tube shorter than or at most as long as calyx lobes.

5a. Leaves narrowly elliptic-lanceolate, length:width ratio 3–4.7; midrib raised above. Fruit obovoid, 1-locular, lens-shaped in cross-section ..... *E. ecarinatum*

5b. Leaves elliptic or obovate, length:width ratio 1.3–3; midrib sunken above. Fruit ellipsoid, 3-locular, rounded-triangular in cross-section.

6a. Leaves thick-leathery, apex obtuse with emarginate tip. Calyx lobes 1.4–1.8 mm long. Fruit ellipsoid, up to 4 mm wide, length:width ratio 2.3 ..... *E. sarawakanum*

6b. Leaves thin-leathery or papery, apex acute with rounded or pointed tip, cuspidate or rarely obtuse with rounded or emarginate tip. Calyx lobes 1–1.2 mm long. Fruit broadly ellipsoid, 4.5–8 mm wide, length:width ratio 1.4–2.1 ..... *E. latifolium*

4b. Stamen tube longer than calyx lobes.

7a. Leaf apex obtuse ..... *E. cuneatum* forma *cuneatum*

7b. Leaf apex acute ..... *E. cuneatum* forma *sumatranum*

1a. Erythroxylum cuneatum (Miq.) Kurz, forma **cuneatum**

J. As. Soc. Beng. 43, 2 (1847) 135. Type: *Wallich Catalogue* no. 4534, "India Orientalis" (holotype K).

Ficus cuneata Wall., Cat. (1828), *nom. nud.*

Urostigma ?cuneatum Miq., Hook. Lond. J. Bot. 6 (1847) 585.

E. burmanicum Griff., Posth. Papers, Not. Pl. As. 4 (1854) 468, *t.* 581, fig. 3. Type: *Griffith s.n.*, Burma, Mergui (K).

E. retusum Bauer ex Teijsm. & Binn., Cat. Hort. Bog. (1866) 214, *nom.* Type: *Cult. Hort. Bot. Bogor* 14430, Java, Bantam (BO).

E. longistipulatum Burck, Ann. Jard. Bot. Btzg. 11 (1893) 193. Type: *Cult. Hort. Bot. Bogor sub III.K.10* (BO).

E. bancanum Burck, Ann. Jard. Bot. Btzg. 11 (1893) 192, *t.* 16. Type: *Cult. Hort. Bot. Bogor sub III.K.32*, Banka, Tg. Pinang (BO).

E. cuneatum var. *bancanum* (Burck) O.E. Schulz., Pfl. R. Heft 29 (1907) 148.

E. platyphyllum Merr., Philip. J. Sc. 3 (1908) Bot. 232. Type: *Whitford & Hutchinson* FB 9285, Philippines, Mindanao, Zamboanga, Port Banga (BO).

Tree to 30 m tall, 50 cm diameter. Twigs dark brown to brown, flattened towards the ends, with prominent stipular scars. Stipules lanceolate, *c.* (2.5–)4–6(–7.5) mm long, distinctly bicarinate. Leaves obovate or elliptic or elliptic-lanceolate, (1.9–)3.5–9.5(–12) × (0.9–)1.9–4.5(–5.8) cm, length:width ratio (1.4–)1.8–2.6(–3.1); base cuneate, apex obtuse with emarginate or rounded tip, papery or thin-leathery; midrib sunken above, prominent below; lateral veins 8–12 pairs, areolation distinct, slightly prominent on both sides, spacing between lateral veins (2–)3–9(–13) mm; petiole (2–)3–7(–9) mm long, 0.5–1 mm thick, glabrous. Flowers in clusters of 2–6, only sometimes solitary and then never exclusively so; pedicels 3–9 mm long, 0.2–0.7 mm thick, glabrous, slightly thickened under the calyx, subtended by 2 bracteoles; calyx-lobes 0.5–1(–1.2) mm high, triangular; petals 5; stamens 10, stamen-tube longer than the calyx-lobe. Fruits ellipsoid, 8–10 × 2.5–4.5 mm, length:width ratio 2.3–3.2, curved, glabrous, tip pointed, rounded-triangular in cross-section, locules arranged in a triangle, with the fertile locule nearly of the same size as 2 sterile locules. Seeds 1 in fertile locule, flattened, with endosperm, *c.* 6–8 × 1.5–3.0 mm.

DISTRIBUTION. Burma, Thailand, Indo-China, Banka and Riouw Islands, Peninsular

Malaysia, Singapore, Anambas and Natuna Islands, Java (Western part, Kangean), Borneo, Philippines, Lesser Sunda Islands (Sumbawa) and Moluccas.

ECOLOGY. Seasonal monsoon forest, lowland mixed dipterocarp forests, beaches; also (rarely) on mountain peaks and limestone.

SPECIMENS EXAMINED—"India Orientalis", *Wallich Catalogue no. 4534* (K). **BURMA.** Mergui, *Griffith s.n.* (K). **THAILAND.** Phang-nga, Ko Yao Yai, *Hansen & Smitinand* 12404 (SING); Bang Sow, *Md. Haniff* SFN 4212 (SING). **PENINSULAR MALAYSIA.** Perlis, Bt. Bintang Forest Reserve, *Whitmore* FRI 484 (KEP, SING); Kaki Bukit, *Kiah* SFN 35259 (KEP, SING); Kedah, Bukit Kayu Hitam, *Symington* FMS 46959 (KEP), Gunong Jerai Forest Reserve, *Yusop* FMS 7716 (KEP), *Rahim* FMS 12362 (KEP, SING), Tangga Reserve, *Saaid FMS 20664* (KEP); Penang, *Griffith s.n.* (K), *Henderson* 189 (SING), Batu Ferringgi, *Stone* 6306 (SING); Perak, Pulau Pangkor, Sungei Pinang, *Hamid* FMS 2311 (KEP, SING), *Ridley* 7937 (SING), Gunong Sondok, *Sofian* SFN 36321 (SING); Selangor, Batu Caves, *Ng* FRI 1636 (KEP), Kuala Selangor, KEP 71150 (KEP); Negri Sembilan, Port Dickson, Teluk Kemang, Cape Rachado Forest Reserve, *Damanhuri* FRI 36006 (KEP), Tampin, *Burkill* 577 (SING), Tampin Forest Reserve, summit of Gunong Tampin, *Loh* FRI 17064 (KEP), *Wong* FRI 32320 (KEP); Malacca, *Griffith s.n.* (K), Bt. Bruang, *Hassan* 20 (SING), Sungei Udang *Ridley* 478 (SING); Kelantan, Lepan Bagan, FMS 32747 (KEP), Sik, *Kochummen* FRI 16786 (KEP), Tanah Merah, *Ahmad* KEP 93543 (KEP); Terengganu, Sungei Paka, *Symington* FMS 26817 (KEP), Ulu Brang, *Moysey & Kiah* SFN 33317 (KEP, SING), Pulau Kapas, *Hume* 72 (SING); Pahang, Kuantan Research Forest, *Soh* FMS 15058 (KEP, SING), Manchali, Sungei Rompin, *Bidin* FMS 15688 (KEP), Pulau Setindan, *Ng* FRI 5104 (KEP), Pulau Tioman, *Henderson* SFN 18482 (KEP, SING); Johore, Pulau Sibu, *Samsuri Ahmad* 15 (KEP), Jason Bay, Sungai Rhu, *Corner* SFN 28476 (KEP, SING), Segamat, Gunong Ledang Forest Reserve, *Saw* FRI 37723 (KEP), Penyabing via Endau, *Md. Shah* 4062 (SING). **SINGAPORE.** Changi, *Ridley* 1806 (SING), *Ridley 1934* (SING), *sine coll.* SFN 519 (SING), *Sinclair* SFN 37935 (SING), *Sidek Kiah & Ali Rahim s.n.* (SING); Pulau Angsa, *Burkill & Md. Shah* HMB 946 (SING); Pelehah, Pulau Sekijang, *Sinclair* SFN 39241 (SING); St. John Island, *Nura & Chin* NK 114 (SING). **BANKA ISLAND.** Tg. Pinang, *Cult. Hort. Bot. Bogor sub III.K.32* (BO). **RIOUW ISLAND.** Pulau Tujuh, *Bünnemeijer* 5869 (BO). **ANAMBAS AND NATUNA ISLANDS.** *Van Steenis* 1333 (BO, SING). **JAVA.** Peutjang Island, Udjung Kulon, *Kostermans, Kuswata, Soegeng & Soepadmo* KKSS 417 (KEP, SAN, SING); Kangean, *Backer* 29043 (SING). **SUMBAWA.** *Elbert* 4139 (BO, K, SING). **BORNEO. SABAH:** Sandakan District, Kuala Meruap, *Lee & Aban* SAN 107458 (KEP, SAN, SING); Northern part of Tambisan Island, *Lee* SAN 107522 (SAN); Pulau Libaran, *Chow* SAN 64569 (SAN); Tambisan, Ganduman Forest Reserve, *Aban & Saikeh* SAN 82275 (K, L, SAN, SAR, SING); Tanjong Peras, *Mail* BNB–FD 3645 (BO, K). **PHILIPPINES.** Mindanao, Zamboanga District, Port Banga, *Whitford & Hutchinson* FB 9285 (BO), *Foxworthy, Demesa & Villamil* FB 13908bis (L), *Stadtmiller, Ferraris & Almagro* FB 20102 (K),

Merrill Bur. Sci. 11637 (BO, K, L, SING). **MOLUCCAS.** Halmahera, *Beguin* 1795 (BO), *Teijsmann s.n.* (BO); Ternate, *Beguin* 1044 (BO), *Teijsmann s.n.* (BO), Ngade, near Laguna, *Alston* 16639 (SING).

The leaf size is very variable. The smallest leaves are found in specimens collected from rocky coasts, islands, mountains and limestones. This form is the predominant form found in Burma, Indo-China, Peninsular Malaysia, Singapore, Java and the Philippines. In Borneo, it is found mainly along beaches and on islands.

1b. Erythroxylum cuneatum (Miq.) Kurz, forma **sumatranum** (Miq.) R.C.K. Chung, **comb. nov.**

E. sumatranum Miq., Fl. Ned. Ind. Suppl. (1862) 200, 512. Type: *Teijsmann s.n.* (= Leiden no. 908. 125–2056), Sumatra, Palembang, Ogan Ulu (holotype L; isotype BO).

E. densinerve O.E. Schulz, Pfl. R. Heft 29 (1907) 142. Type: *Beccari* PB 3623, Sarawak (holotype K).

E. borneense Merr., Pl. Elm. Born. (1929) 112. Type: *Elmer* 21385, North Borneo, Tawau (holotype K; isotypes L, SING, U).

Tree to 25 m tall, 30 cm diameter. Twigs brown to grey-brown, flattened towards the ends, with prominent stipular scars. Stipules triangular, *c.* (2–)2.5–4(–5.0) mm long, distinctly bicarinate. Leaves elliptic to narrowly elliptic, lanceolate or rarely obovate, (2.8–)4.2–7.7(–10.2) × (0.9–)1.7–2.8(–3.2) cm, length:width ratio (1.7–)2.2–3.1(–3.8); base acute to obtuse, apex acute with rounded or emarginate or rarely pointed tip, papery or thin-leathery; midrib sunken above, prominent below; lateral veins 8–15 pairs, areolation distinct, slightly prominent below, faint above, spacing between lateral veins (2–)3–7(–9) mm; petiole (2–)3–5(–7) mm long, 0.5–1 mm thick, glabrous. Flowers in clusters of 2–6(–8); pedicels 3–10 mm long, 0.2–0.5 mm thick, glabrous, slightly thickened under the calyx, subtended by 2 bracteoles; calyx-lobes 0.5–1.2 mm high, triangular to lanceolate; petals 5; stamens 10, stamen-tube longer than the calyx-lobe. Fruits ellipsoid, 9–12 × 2.5–4 mm, length:width ratio 2.6–4, curved, glabrous, tip pointed, rounded-triangular in cross-section, locules arranged in a triangle, with the fertile locule nearly of the same size as 2 sterile locules. Seeds 1 in fertile locule, flattened, with endosperm, *c.* 8–10 × 1.5–2.5 mm.

DISTRIBUTION. Sumatra, Borneo and the Philippines.

ECOLOGY. In Borneo in mixed dipterocarp forests.

SPECIMENS EXAMINED—SUMATRA. Palembang, Ogan Ulu, *Teijsmann s.n.* (= Leiden no. 908.125–2056) (BO, L); Lampong District, Soekadana, Terbanggi Agoengbaroe,

Van Steenis bb. 31037 (SING). **BORNEO. SABAH:** *Goklin* BNB–FD 1568 (K); Kinabatangan District, Lamag, Karamuak, *Leopold Madani* SAN 81763 (AA, K, KEP, L, SAN, SAR, SING); Lahad Datu District, Bakapit Catchment Area, *Ahmad Talip* SAN 52748 (K, SAN), Kennedy Bay, Mile 4, *Wood* A 4261 (A, BRI, KEP, L, SING), Kretam, *Wood* A 4818 (K, KEP, SING), Sepagaya Suai-suaian Silam, Mile 9, *Muin Chai* SAN 29713 (KEP, SING), Silam, Mile 10, *Richard Benideh* SAN 58984 (SAN), Ulu Segama Forest Reserve, *Joseph, Lideh & Ahad* SAN 116853 (SAN), Ulu Sg. Danum, *Cockburn* SAN 85081 (K, KEP, KLU, L, SAN, SAR, SING), Jalan Taliwas, Km 12, *Joseph & Good* SAN 119332 (KEP, SAN); Sandakan District, Lungmanis, *Sabah Timber Company Staff* SAN 61686 (SAN), Sepilok, Mile 14, *Aban Gibot* SAN 82076 (SAN); Tawau District, Apas Road, Mile 15.5, *W. Pereira* SAN 44210 (K, L, SAN), *Elmer* 21385 (K, L, SING, U), Quoin Hill Road, Mile 17, *Aban Gibot* SAN 30377 (BO, K, KEP, L, SAN, SAR, SING), Ulu Sg. Apas, Quoin Hill Road, *Aban Gibot* SAN 32437 (K, L, SAN). **SARAWAK:** 1st Division, Kuching District, Semengoh Forest Reserve, *Haji Bujang* S. 12753 (B, K, L, SAN, SAR), Semengoh Forest Reserve, *Omar* S. 370 (K, SING); *Beccari* PB 3623 (K). **KALIMANTAN:** Tanah Boemboe, Kamp. Baroe, bb. 13295 (SING). **PHILIPPINES.** Dinagat Island, *Ramos & Pascasio* Bur. Sci. 35152 (SING).

The leaf size in this form, which is absent from Peninsular Malaysia, is less variable. Payens (1958) also noted that *E. cuneatum* occurred in Celebes and the Islands off W New Guinea. Material of this has not been studied for this account and it is uncertain whether one or both, or other forms occur in these places. Nevertheless, the nomenclature of the typical and variant forms discussed here does not depend on this and no validly published synonyms of *E. cuneatum* were based on these provenances.

2. Erythroxylum ecarinatum Burck

Ann. Jard. Bot. Btzg 11 (1893) 191. Type: Cult. Hort. Bot. Bogor, from Moluccas (BO).

E. salomonense White, J. Arn Arb. 31 (1950) 89. Type: *Walker & White* BSIP 156, Solomon Islands, New Georgia, Vanganu Island, near Kaukosi River (BO).

Tree to 30 m tall. Twigs glabrous, dark brown, flattened towards the ends, with prominent stipular scars. Stipules oblong-lanceolate, *c.* (4–)8–11(–20) mm long, rarely carinate. Leaves crowded at the ends of twigs, narrowly elliptic-lanceolate, (6–)7–12(–17) × (1.3–)1.9–3.8(–5) cm, length:width ratio 3–4.7; base cuneate, apex acuminate with rounded or pointed tip, papery; midrib raised above, prominent below; lateral veins 8–14 pairs, areolation distinct, slightly prominent on both sides, spacing between lateral veins (2–)4–9(–11) mm; petiole (3–)4–7(–9) mm long, 0.7–1 mm thick, glabrous. Flowers in clusters of (2–)4–8(–20); pedicels 5–9 mm long, *c.* 0.7–1 mm thick, glabrous, thickened under the calyx, subtended by 2 bracteoles; calyx-lobes 0.8–1.2 mm high, triangular; petals 5; stamens 10, stamen-tube shorter than or at most as long as the calyx-lobe. Fruits obovoid,

5–12(–17) × 3–6(–8) mm, length:width ratio 1.6–2.5, often curved, glabrous, sometimes slightly oblique with a rounded top, len-shaped in cross-section, 1-loculed. Seeds 1, without endosperm, *c.* 2.5–7 × 1.5–3 mm.

DISTRIBUTION. Celebes, Moluccas (Halmaheira, Sula, Buru, Ceram), New Guinea, Queensland, Melanesia (Solomon Islands: New Georgia).

ECOLOGY. Lowland to montane primary forest up to 2000 m. Often found on slopes and mountain ridges, on rocky and clayey soils.

SPECIMENS EXAMINED—CELEBES. Oesoe, Cel/II 396 (SING). **MOLUCCAS.** Ceram, Masohi, Wae Ruatan/Wae Ruwata catchment areas, *Burley, Tukirin & Ismail* 4303 (KEP); Ambon, *Robinson* 1854 (SING), Weda, Tiloppe, bb. 24872 (SING), bb. 24901 (SING). **NEW GUINEA.** Gulf, near Ihu, *Craven & Schodde* 705 (SING); New Britain, Talasea, South of Cape Ruge, *Frodin* NGF 26761 (SING), SW Mt. Talawe, *Frodin* NGF 26853 (SING); New Ireland, Namatanai, Danfu river, *Coode & Lelean* NGF 46088 (SING); Noemfoor, Jembeba, *Koster* BW 1041 (SING); *Carr* 13355 (SING); Kainantu, *Henty & Coode* NGF 29231 (SING); Koitaki, *Carr* 12881 (SING), *Carr* 12249 (SING), *Carr* 15652 (SING); Bensbanck, *Ridsdale & Galore* NGF 33477 (SING), *Ridsdale* NGF 33591 (SING); Boridi, *Carr* 13269 (SING); Sogeri, *Jackson* 4156 (SING), *Streimann* LAE 51593 (SING); Morehead, Sibidiri, Mai Kussa, *Henty & Katik* NGF 38772 (SING); Mayu Island, Milne Bay, Raba-raba, junction of Ugat & Mayu river, *Streimann & Katik* NGF 28660 (SING), *Leach & Katik* LAE 56053 (SING); Morobe, Yunzaing, *Clemens 3512* (SING). **QUEENSLAND.** Boonjie, Atherton Tableland, *Kajewski* 1162 (SING), *Kajewski* 1274 (SING). **SOLOMON ISLANDS.** *Whitmore* BSIP 1842 (SING); N Kolombangara, *Gafui* BSIP 8780 (SING); SE Kolombangara, *Mauriasi* BSIP 8549 (SING), *Mauriasi* BSIP 9578 (SING), *Mauriasi* BSIP 11418 (SING); NW Kolombangara, *Mauriasi* BSIP 8819 (SING); NE Kolombangara, *Mauriasi* BSIP 7616 (SING); Guadalcanal, Mt. Austen, *Whitmore* BSIP 1842 (SING); NW Guadalcanal, Mt. Mambulu, *Kere* 4903 (SING); SW Guadalcanal, Wanderer Bay, *Mauriasi* BSIP 12321 (SING); S Vella Lavella, Oula river, *Kotali* BSIP 11328 (SING); S San Cristobal, W Tetere Village, *Gafui* BSIP 12573 (SING); New Georgia, Vanganu Island, near Kaukosi river, *Walker & White* BSIP 156 (BO), Gizo Island, *Whitmore* BSIP 3026 (SING); NW New Georgia, Vaimbu river, *Cowmeadow* BSIP 3278 (SING); SE New Georgia, Viru Harbour, *Maenuu* BSIP 5199 (SING), Tita river, *Burn-Murdoch* BSIP 7196 (SING); San Cristobal, Wairaha river, *Whitmore* BSIP 4277 (SING); Samusodu, SW Station Ysabel, *Beer* BSIP 7282 (SING).

3a. Erythroxylum iwahigense Elmer, forma **iwahigense**

Leafl. Philip. Bot. 5 (1913) 1776. Type: *Elmer* 13227, Philippines, Palawan, Puerto Princesa, Mt. Pulgar (holotype L; isotypes BO, K).

E. cuneatum (*non* (Miq.) Kurz) *sensu* Payens, Fl. Males. 1, 5 (1958) 549, *pro parte, quoad syn. E. iwahigense.*

Small tree to 10 m tall, 5 cm diameter. Twigs dark brown, flattened towards the ends, with prominent stipular scars. Stipules triangular, (1.5–)2–2.5(–3) mm long, distinctly bicarinate. Leaves elliptic-lanceolate, (1.9–)4.1–8.3(–9.8) × (1.1–)1.9–3(–3.6) cm, length:width ratio (1.6–)1.9–2.8(–3); base cuneate to acute, apex acute with rounded or emarginate tip or rarely obtuse with emarginate tip, thin-leathery; midrib sunken above, prominent below; lateral veins (6–)9–12 pairs, areolation distinct, slightly prominent to faint on both sides, spacing between lateral veins (3–)4–8(–10) mm; petiole (2–)3–5(–6) mm long, 0.5–0.1 mm thick, glabrous. Flowers solitary; pedicels 15–25 mm long, 0.3–0.4 mm thick, glabrous, slightly thickened under the calyx, subtended by 2 bracteoles; calyx-lobes 1–1.2 mm high, triangular; petals 5; stamens 10, stamen-tube shorter than or at most as long as the calyx-lobe. Fruits ellipsoid, 8–11 × 3–5 mm, length:width ratio 1.8–2.9, curved, glabrous, with rounded tip, rounded-triangular in cross-section, locules arranged in a triangle, with fertile locule nearly of the same size as 2 sterile locules. Seeds 1 in fertile locule, flattened, with endosperm, *c.* 6–9 × 1.5–3 mm.

DISTRIBUTION. Philippines (Palawan island).

ECOLOGY. Montane forest.

SPECIMENS EXAMINED—PALAWAN. Puerto Princesa, Mt. Pulgar, *Elmer* 13227 (holotype L; isotypes BO, K); Narra, Victoria Peaks, Trident Mining Company concession area, below Mc. Gregor's tunnel, *Ridsdale* SMHI 1798 (KEP), Narra, Victoria Peaks, Trident Mining Company concession area, along access track, *Ridsdale* SMHI 1823 (KEP), Narra, Victoria Range, vicinity of Trident mine, *Soejarto & Madulid* 6173 (KEP).

3b. Erythroxylum iwahigense Elmer, forma **calcicola** R.C.K. Chung, **form. nov.** *A forma iwahigense in foliis ellipticis obovatisve crasse coriaceis nervorum lateralium interveniis 1–2(–2.5) mm latis differt. Typus: Paul Chai S. 39898, Sarawak, 4th Division, Gunong Mulu National Park, Gunong Buda (holotypus SAR; isotypi K, KEP, L, MO, SAN).* (Fig. 1)

Shrub or treelet to *c.* 1.5 m tall. Twigs glabrous, dark brown, flattened towards the ends with prominent stipular scars. Stipules triangular, 2–3 mm long, distinctly bicarinate. Leaves elliptic or obovate, (1.6–)2.4–4(–4.3) × (1.1–)1.3–1.8(–2) cm, length:width ratio (1.5–)1.7–2.3(–2.5); base cuneate, apex acute with rounded or emarginate tip, rarely obtuse with rounded tip; thick-leathery, drying dark brown to reddish brown on both sides, glabrous on both surfaces; midrib sunken on the upper surface, raised below; lateral veins (12–)14–20 pairs, fine, forming marginal loops and anastomosing irregularly with the intermediate, intercostal and intramarginal veins to form a distintive reticulate venation,

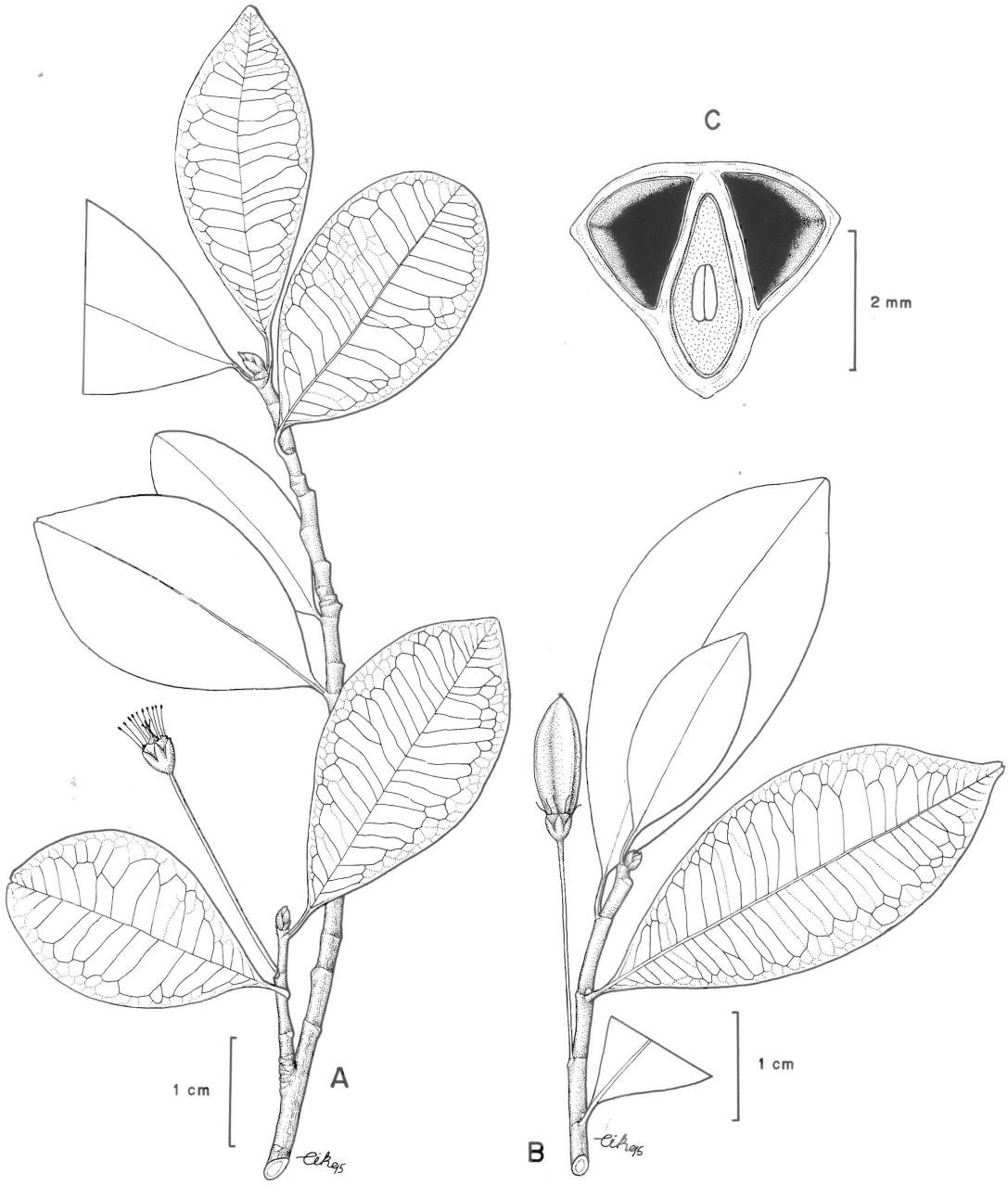

Fig. 1. *Erythroxylum iwahigense* forma *calcicola*. **A.** Flowering leafy twig. **B.** Fruiting leafy twig. **C.** Fruit in cross section. All from S. 39898.

prominent to faint on both sides, spacing between lateral veins 1–2(–2.5) mm; petioles (2–) 3–4 mm long, 0.5–0.8 mm thick, glabrous. Flowers solitary; pedicels 16–19 mm long, *c.* 0.5 mm thick, glabrous, thickened under the calyx, subtended by 2 bracteoles; calyx-lobes 1.1–1.5 mm high, triangular; petals 5; stamen-tube shorter than or at most as long as the calyx-lobe. Fruits ellipsoid, up to 12 × 4.5 mm, length:width ratio *c.* 2.6, glabrous, tip pointed, rounded-triangular in cross section, locules arranged in a triangle, with the 2 sterile ones as large as the fertile one, not curved. Seeds 1 in fertile locule, flattened, with endosperm, *c.* 10 × 2.5 mm.

DISTRIBUTION. Endemic to Borneo (Sarawak), known only from the type.

ECOLOGY. Limestone hills.

4. Erythroxylum kochummenii Ng

Gard. Bull. Sing. 28 (1976) 235. Type: *Kochummen* KEP 93146, Peninsular Malaysia, Selangor, Ulu Gombak Forest Reserve (holotype KEP; isotype SING).

Tree to 27 m tall, 50 cm diameter. Twigs dark brown to grey-brown, flattened towards the ends with prominent stipular scars. Stipules lanceolate, 3–4 mm long, distinctly bicarinate. Leaves broadly elliptic or elliptic, (3.5–)4.7–7.4(–7.6) × (1.6–)2–3.5(–3.8) cm, length:width ratio (1.7–)1.8–2.2(–2.3); base cuneate to acute, apex acuminate with rounded tip, papery; midrib sunken above, prominent below; lateral veins 10–14 pairs, areolation distinct, slightly prominent on both sides, spacing between lateral veins (3–)4–7(–9) mm; petiole (6–)7–10(–11) mm long, 0.5–0.8 mm thick, glabrous. Flowers solitary; pedicels 5–10 mm long, 0.2–0.4 mm thick, glabrous, slightly thickened under the calyx, subtended by 2 bracteoles; calyx-lobes 0.8–1 mm high, triangular; petals 5; stamens 10, stamen-tube shorter than or at most as long as the calyx-lobe. Fruits broadly obovoid, 20–22 × 15–20 mm, length:width ratio 1–1.4, not curved, glabrous, with a truncate top, more or less rounded in cross-section, locules arranged in a row, with the fertile locule much narrower than 2 sterile locules. Seeds 1 in fertile locule, flattened, with endosperm, *c.* 18–21 × 9–13 mm.

DISTRIBUTION. Endemic to Peninsular Malaysia (Selangor, Malacca and Kelantan only).

ECOLOGY. Hill forest.

SPECIMENS EXAMINED—PENINSULAR MALAYSIA. Selangor, Ulu Gombak Forest Reserve, *Kochummen* KEP 93146 (holotype KEP; isotype SING), *Symington* KEP 51730 (KEP); Malacca, Merlimau, *Alvins* 1848 (SING); Kelantan, Ulu Lebir Forest Reserve, *Suppiah* FRI 17705 (KEP, SING).

5. Erythroxylum latifolium Burck.

Ann. Jard. Bot. Btzg 11 (1893) 192. Type: *Teijsmann s.n.*, Lingga (holotype BO).

E. latifolium var. *angustatum* O.E. Schulz, Pfl. R. Heft 29 (1907) 144. Type: *Teijsmann s.n.*, Billiton, Tanjong Pandang (BO, L).

E. latifolium var. *longipetiolatum* Boerlage & Koorders, Ic. Bog. 1 (1897) *t.* 6. Type: *Koorders s.n.*, Sumatra, Boewatan (BO, L).

E. cuneatum (*non* (Miq.) Kurz) *sensu* Payens, Fl. Males. 1, 5 (1958) 549, *pro parte, quoad syn. E. latifolium, incl.* var. *angustatum* O.E. Schulz & var. *longipetiolatum* Boerl. & Koord.

Shrub or small tree to 6 m tall. Twigs brown to grey-brown, flattened towards the ends, with prominent stipular scars. Stipules triangular, *c.* (2.5–)3.0–3.5(–4.0) mm long, distinctly bicarinate. Leaves elliptic or rarely obovate, (5.5–)6.2–13(–17) × (2.5–)2.8–5.7(–6.4) cm, length:width ratio (1.8–)1.9–2.8(–3); base cuneate to acute, apex acute with rounded or pointed tip, sometimes cuspidate or rarely obtuse with rounded or emarginate tip, papery or thin-leathery; midrib sunken above, prominent below; lateral veins 9–14 pairs, areolation distinct, slightly prominent below, faint above, spacing between lateral veins (3–)5–13(–16) mm; petiole (3–)4–8(–10) mm long, 0.8–1.5 mm thick, glabrous. Flowers in clusters of 2–4; pedicels 5–6 mm long, 0.8–1 mm thick, glabrous, slightly thickened under the calyx, subtended by 2 bracteoles; calyx-lobes 1–1.2 mm high, triangular; petals 5; stamens 10, stamen-tube shorter than or at most as long as the calyx-lobe. Fruits broadly obovoid, 9–12 × 4.5–8 mm, length:width ratio 1.4–2.1, not curved, glabrous, tip pointed, rounded-triangular in cross-section, locules arranged in a triangle, with the fertile locule nearly of the same size as 2 sterile locules. Seeds 1 in fertile locule, flattened, with endosperm, *c.* 7–9 × 3–5 mm.

DISTRIBUTION. Sumatra, Banka, Billiton, Lingga, Anambas and Natuna Islands, and Borneo.

ECOLOGY. Lowland mixed dipterocarp, *kerangas* and peatswamp forests.

SPECIMENS EXAMINED—SUMATRA. *Koorders* 22320β (BO). **BANKA ISLAND.** Soengei Liat, *Teijsmann s.n.* (BO); Djeboes, *Teijsmann s.n.* (BO). **BILLITON.** Tanjong Pandang, *Teijsmann s.n.*, (BO, L). **LINGGA ISLAND.** *Teijsmann s.n.* (holotype BO); *Hullett s.n.* (SING). **ANAMBAS AND NATUNA ISLANDS.** N Jemaja, Telok Padang, *Henderson* SFN 20428 (BO, K, SING). **BORNEO. SARAWAK:** 4th Division, Miri District, Baram, *Hose* 179 (K), Marudi Forest Reserve, *Chew* CWL 975 (SAR, SING), *Martin* S. 38236 (K, KEP, L, MO, SAN, SAR), Lambir Hills National Park, *Ilias & Yeo* S. 38335 (K, KEP, L, SAN, SAR), *Sibat ak Luang* S. 25076 (A, BO, K, L, SAN, SAR, SING), Sg. Dalam Forest Reserve, *Brunig* S. 987 (SAR); 6th Division, Sarikei District, Rejang

Delta, Lassa Protected Forest, *Hamdi* S. 27823 (SAR). **BRUNEI:** Belait District, Badas Forest Reserve, *Anderson* S. 5691A (SAR), *Smythies, Ashton & Wood* S. 5843 (KEP, SAR, SING), *Wong* WKM 9 (K, SAN, SING), *Van Niel* 4113 (L), Bt. Sawat, *Thomas* 218 (K), *Coode* 7346 (K), *Ashton* BRUN 980 (K), Kuala Badas, *Hotta* 13027 (L), Lumut Hills, *Fuchs* 21201 (SAR); Tutong District, Tutong, *Ashton* S. 1174 (SAR), *Van Niel* 4293 (L), *Jacobs* 5688 (B, BH, BRUN, CANB, G, K, L, US, S).

6. Erythroxylum sarawakanum R.C.K. Chung, **sp. nov.** *E. latifolio affinis sed foliis crasse coriaceis obovatis ellipticisve apice obtuso acumine emarginato, calycis lobis longioribus 1.4–1.8 mm longis, fructibus ellipsoideis ad 4 mm latis longitudinis/latitudinis ratione 2.3 differt. Typus: Ilias Paie S. 17894, Sarawak, Bako National Park (holotypus SAR; isotypi A, BO, K, L, SAN, SING).* (Fig. 2)

Shrub or treelet up to *c.* 5 m tall, 4 cm diameter. Twigs glabrous, grey-brown, flattened towards the ends, with prominent stipular scars. Stipules triangular, 2–2.5 mm long, distinctly bicarinate. Leaves obovate or elliptic, (4.3–)5.5–9(–10.5) × (2.2–)2.8–5(–5.5) cm, length:width ratio (1.3–)1.6–2.1(–2.4); base broadly cuneate to acute, apex obtuse with emarginate tip; thick-leathery, drying brown and glabrous above, pruinose below; midrib sunken above, raised below; lateral veins (6–)8–12 pairs, fine, joining and forming marginal loops and anastomosing irregularly with the intermediate, intercostal and intramarginal veins to form a distintive reticulate venation, prominent above, faint below, spacing between lateral veins (4–)7–12(–13) mm; petioles (6–)7–10(–12) mm long, 1–2 mm thick, glabrous. Flowers in clusters of 2–4; pedicels 4–5 mm long, *c.* 0.5 mm thick, glabrous, thickened under the calyx, subtended by 2 bracteoles; calyx-lobes 1.4–1.8 mm high, triangular; petals 5; stamens 10, stamen-tube shorter than or at most as long as the calyx-lobe. Fruits ellipsoid, 9 × 3.5–4 mm, length:width ratio *c.* 2.3, glabrous, with a rounded top, rounded-triangular in cross-section, locules arranged in a triangle, with 2 sterile ones as large as fertile one, seldom curved. Seeds 1 in fertile locule, flattened, with endosperm, *c.* 6–8 × 2.5–3 mm.

DISTRIBUTION. Endemic to Borneo (Sarawak only).

ECOLOGY. Lowland to hill forests, to *c.* 700 m alt.

SPECIMENS EXAMINED—BORNEO. SARAWAK: 1st Division, Kuching District, Bako National Park, *Ilias Paie* S. 17894 (holotype SAR; isotypes A, BO, K, L, SAN, SING), *Sinclair & Kadim* S. 10324 (A, B, E, FI, K, L, SAR, SING), *Jugah, Saupel & Mohd. Ismail* S. 73601 (K, KEP, KLU, L, MO, SAN, SAR); Mt. Matang, *J. & M.S. Clemens* 22354 (K); Gunong Santubong, *Martin* S. 37668 (K, KEP, L, SAR), *Jugah, Saupel &.Mohd. Ismail* S. 73603 (K, KEP, KLU, L, MO, SAN, SAR).

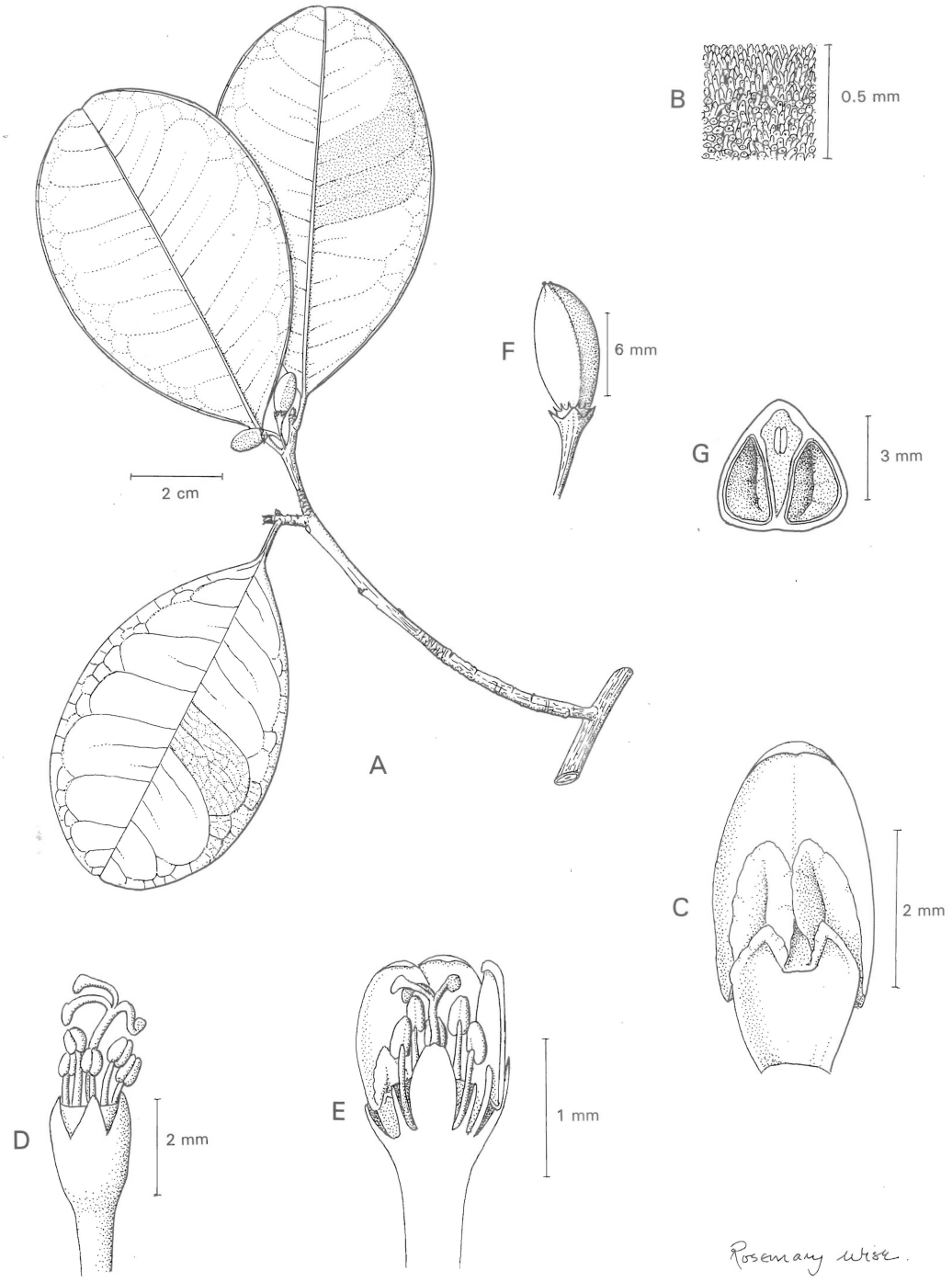

Fig. 2. *Erythroxylum sarawakanum*. **A.** Fruiting leafy twig. **B.** Detail of lower leaf surface. **C.** Posterior clawed petal with a 3-lobed ligule-like appendage. **D.** Mature flower bud with petals removed. **E.** Flower bud in longitudinal section. **F.** Fruit. **G.** Fruit in cross section. All from S. 17894 except **C, D** & **E**, from S. 73603.

E. sarawakanum differs from *E. latifolium* by its thick-leathery leaves, which are obovate or elliptic, and its obtuse leaf apex with an emarginate tip. The longer calyx lobes (1.4–1.8 mm long) and ellipsoid fruit (up to 4 mm wide, with a length:width ratio of 2.3) also distinguish it from the latter species.

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